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ABSTRACT

The relationships between the size of units within institutes, departments, and schools and their teaching, research, and service outputs or the structure of their resources was investigated at two national institutes of technology funded by the government of Switzerland. Resources and outputs were measured in terms of total expenditures, hours of teaching, publications, citations, and a variety of secondary indicators. Two methods were used for analysis of the institutes. The first gave a series of partial results, from a sectoral standpoint, providing a graphic study of variations in several "independent" relationships. The second analytic method was an attempt at a multidimensional approach, achieved by considering several variables at once. This approach required an aggregation of data that led to some loss of information (from a sectoral standpoint). The approach aimed at the combination of partial performances, each defined as the relationship between an output indicator and the indicator measuring total input. The study findings suggest that (1) there is not one size effect, but several differentiated effects depending on the relationship and level considered; (2) the size effect is usually combined with other factors; and (3) there may be a positive effect of size regarding outside sources of finance and external professional recognition. Sample graphs obtained by the first (graphic) and external professional recognition. Sample graphs obtained by the first (graphic) approach are included. (SC)

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PERFORMANCE INDICATORS FOR INSTITUTIONS OF HIGHER EDUCATION

EFFECTS OF SIZE WITHIN TWO INSTITUTES OF TECHNOLOGY

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ABSTRACT

Some aspects are presented from a study designed to illustrate relations between the size of units - within institutes*, departments and schools - and their teaching, research and service outputs, or the structure of their resources.

Resources and outputs were measured by means of indicators: total expenditure, hours of teaching, publications, citations, etc., size being defined by reference to expenditure on staff.

The principal results achieved by a direct but sectorial approach are set out first, relating mainly to research activities (and outside services) undertaken by institutes.

An attempt at a multidimensional analysis is then described as a method better able to explain the overall performance of a university institute, in relative terms.

(* In this paper "school" refers to the institution as a whole, while "institute" means a basic (research) unit, except in the name "Federal Institute of Technology").

CONTENTS Page

1. Subject matter and aims of the study..... 3
2. The approach adopted..... 4
3. Graphic study..... 6
4. General conclusions..... 11
5. Attempt at multidimensional analysis..... 11
6. Short bibliography..... 17

1. SUBJECT MATTER AND AIMS OF THE STUDY

1.1 The Two Federal Institutes of Technology (EPF in French, ETH in German)

Although they each have their own history (dating back more than a hundred years) and differ in many respects, notably in size, the two Swiss technical universities both come under the same authority - from its creation in the case of the Zürich Institute and since 1969 for that of Lausanne - and therefore have a common source of finance, namely the Federal Government. The latter acts through a supervisory and co-ordinating body - the Board of the Federal Institutes of Technology.

Both schools contain departments for the usual subjects: architecture, civil engineering, rural engineering, mechanical engineering, electrical engineering, physics, mathematics and chemistry. The Zürich Institute of Technology (ETHZ), which is the larger of the two, also has departments of agronomics, forestry, natural sciences, pharmacy and social and human sciences. This fact, a result of past history, and the geographical situation explain the differences set out below (1975 figures but which have not significantly changed):

	ETHZ	EPFL
Number of students enrolled (excluding part-time students)	7,185	1,604
of whom: studying for doctor's degree	1,200	183
Number of professors (posts)	265	96
Total Staff (including teachers), in full-time equivalents	3,725	942

Excluding the central services, staff are allocated to the basic units, i.e. the institutes, laboratories and professorships where research is carried out. These units - about a hundred at ETHZ and some 50 in the EPFL - are proportionally more numerous in the latter, hence on average smaller (practically half the size). At the EPFL institutes are grouped into departments both for teaching and research purposes. This is not the case at ETHZ where teaching is the responsibility of divisions to which one may allocate areas each covering a number of institutes. Together with the substantial (post-)graduate teaching in both schools, the importance of research and service activities must be especially emphasized.

1.2 Aims of the Study

Faced with problems of resource allocation between the two schools and within each of them, particularly in a situation where available resources are little increased, the EPF Board realised that it would be useful to have at its disposal

information which would aid decision-making in as documented and objective a form as possible. As a result a working group was instructed to study the effects of size within the EPF.

By size-effect is meant any systematic effect or trend which shows up - at any level - in teaching, research and service outputs or the structure of resources, and which can essentially be attributed to the size of the units concerned. The aim of the study was therefore to reveal these effects of the three levels of schools, "departments" and especially the basic units (institutes). It was not intended to be an economic analysis, e.g. of the "unit cost" type, but a comparative study of the output of units, notably scientific output. The aim was to provide useful information for planning and organisation of the schools, especially as regards the allocation of activities and resources and the structure of units.

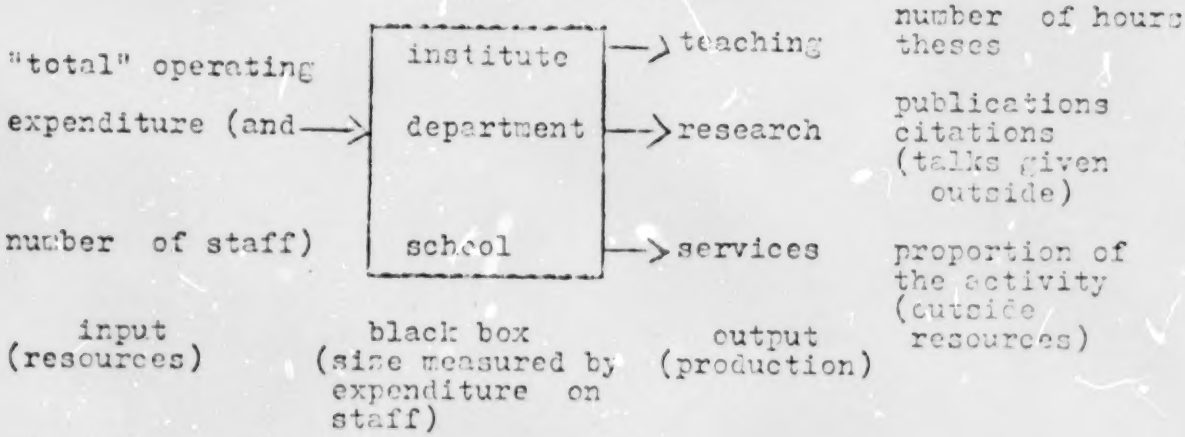
2. THE APPROACH ADOPTED

2.1 The Model

An analysis of the "unit cost" type was excluded from the start, mainly because it was largely impractical to allocate costs separately among the different activities of a university unit, particularly where research and services play a major role, and also because the aim was to make a comparative measurement of scientific output rather than to assess performance from the economic standpoint.

A simple model was used of the "input-black box-output" type which was assumed to be valid at each of the three levels considered. Input covers all resources, both human and financial. Size, which should be characterised by several factors, was measured by means of staff expenditure. Output forms a whole but cannot be measured as such and consists of measurements - by means of indicators - of main activities, namely teaching, research, and services performed for third parties (see figure 1 below).

Figure 1. THE MODEL



Matters relating to the teaching provided - as seen by the student - and to student numbers can only be measured in relation to departments and schools, having regard to the way they are organised. Such matters are thus complementary and are only partially relevant to the input-output model which is valid up to institute level. In order fully to understand this peculiarity - i.e. that student numbers appear neither as inputs nor outputs - reference should be made to what was said above, concerning the importance of research and services and the fact that the study especially dealt with institutes (basic units).

Having regard to the indicators chosen, which are defined below, a sort of data bank had to be set up in each school, naturally on standard lines, since the data required - when available - was not always in the appropriate form. This necessary task was carried out in close co-operation with the administrative services of the two schools, using available information and thus not requiring investigation of the units which were to be covered by the study. Although such basic data covered several successive years, the analysis concentrated on the last i.e. 1975, the study having been started in the summer of 1976. A survey was thus made of a situation existing at a given point in time.

2.2 The indicators

As regards input, nearly all operating expenditure - hence not including depreciation or rent - were recorded (except for a few services such as telephones or postal charges) and broken down between staff and other expenditure and according to the source of finance. Direct expenditure allocated to the institutes represents 85 per cent of total expenditure recorded. It should be stressed that available resources were calculated in terms of expenditure rather than cost. Numbers of staff, the number of posts - in full-time equivalents - divided into three major categories, provided a further measurement the significance of which was to be immediately apparent.

As concerns output, a main indicator was defined for each of the three major activities, and account was also taken of some secondary indicators. In the case of teaching, the course, exercise and laboratory hours per week supervised by professors and other teachers attached to the different units (in accordance with the curricula) were regarded as the primary factor, while theses prepared under the supervision of such staff were a secondary measurement (linked moreover to research).

Research was measured first according to the number of publications and secondly the number of citations. Publications were counted by taking the annual reports of institutes, by averaging the number of publications for 1974 and 1975, and including under separate heads, monographs, specialised articles and other publications. For citations, the Science Citation Index was used. Citations in 1975 were included where they related to articles published from 1970 to 1975 and whose authors

appear as authors of publications - and who belonged to the institute concerned - in the annual reports for either 1974 or 1975. It should be recalled that this index deals, notably through the medium of English-language periodicals, mainly with exact and natural sciences, and only partially with the engineering disciplines.

As regards services carried out for third parties, an assessment was made of the proportion of total activity devoted to expert appraisals and other services. Among the data used for obtaining secondary indicators, mention should be made of the numbers of talks presented outside.

The output indicators referred to above were each related to the indicator measuring input - in most cases total expenditure, sometimes number of posts - with a view to making use of them in the two methods of analysis described below. It may be noted that the relations between indicators thus obtained do in fact represent performance. It may be of use to point out that the aim of the study was not to develop the best possible indicators, but to make the best use of accessible data. Thus in measuring output reference was deliberately made only to directly quantifiable items (with one exception, the assessment of service activities) in spite of the fact that this imposed limitations and involved an arbitrary element, in particular owing to partial lack of judgements as to quality. This lack is in fact only partial since citations, extra-budgetary resources and talks given outside nevertheless implies a certain assessment of the quality of output.

2.3 Method of analysis

For schools and departments or subject areas, data obtained by aggregation were compared in various ways, account being taken of the secondary approach "teaching available/number of students".

For analysis in relation to institutes, two methods were used. The first, which is relatively simple, gave a series of partial results, from a sectorial standpoint (graphic study of variations in several "independent" relationships). The second, which is more complex, is an attempt at a multidimensional approach. The two methods are described below, the first for its results - of which a selection has been made relating mainly to research and services - the second above all as a methodological experiment.

3. GRAPHIC STUDY

3.1 Introduction

As a first approach to the problem of size effects, a graphic representation can be made of the direct relationship between a performance or structural indicator y and the size of

a unit x. This method has the advantage for a first approach of being simple and limiting the number of a priori assumptions or models (1). On the other hand, observations can only indicate associations between variables and not reveal causal relationships. Moreover, the plotting of graphs, in spite of possible tricks of presentation, is in principle a uni-dimensional method.

A number of graphs were plotted by computer, either for departments (subject areas), for all institutes taken together, or for those institutes covering a particular group of disciplines. Both schools were considered in every case.

The graphic approach has three objectives: 1) a visual and complete description of the link between an (performance or structural) indicator and size, 2) an analysis of the average behaviour of units in this respect for different size categories, 3) to some extent show the influence of the school (MTHZ, LPFL) to which the unit belongs and of the discipline concerned.

3.2 Reading the graphs

3.2.1. Scales. The indicator to be represented is shown on the Y-axis. The size of the unit, measured in terms of staff expenditure, is shown on the X-axis using a logarithmic scale.

The extremes of the scales are shown, in round figures, at the ends of the axes. The exact figures and the divisions of the scale are set out underneath the graph. The starting point of the axis does not always correspond to the zeros on the scales. This is due to the automatic procedure used to set out the points to be represented.

3.2.2 The points represented. A given unit (institute or department) is represented on the graph by a special sign for the discipline concerned, usually a letter in the case of LPFL and a number or other special sign for MTHZ.

The sign < in the right-hand margin of the graph indicates the arithmetical average y_u of the indicator calculated for all the points on the graph (weighted in relation to institutes or departments).

3.2.3 Identification of the graphs. The encircled letter in the upper right hand corner of the graph shows that the units concerned are:

D departments (subject areas)

I all institutes of the two schools

(1) For example postulating linear relationships.

I_1 Institutes of the two schools within group of disciplines 1: architecture, civil engineering, rural engineering

I_2 Institutes of the two schools within group 2: mechanical engineering (+ materials), electrical engineering

I_3 Institutes of the two schools within group 3: chemistry, physics, mathematics

I_4 Institutes of [illegible] in fields with no equivalent at EPFL, pharmacy, natural sciences, forestry, agronomy, human and social sciences

I_r Institutes of the two schools within groups 1, 2 and 3, i.e. those present in both schools ([illegible] reduced + EPFL)

The graphs chosen for this paper relate only to groups D, I and I_3.

3.2.4 Size categories. The graphs dealing with institutes are divided into size categories or divisions: five divisions in case I and four in case I_3. The respective sizes of these categories, measured in terms of staff expenditure, progress exponentially.

The distribution of points within a size category is characterized by two statistical values, represented on the graph: an average value y_m and standard deviation s:

The mean value of the indicator, arithmetically weighted for institutes within a given size category, is shown by a horizontal segment:

ZZZZZ: Mean for institutes in the category which belong to the LTH

LLLLL: Mean for institutes in the category which belong to EPFL

+++ or === : Mean for all institutes in the category. The second sign is used where this mean conceals one or other of the means ZZZZZ and LLLLL.

These mean values have not been plotted when the weighting relates to less than three points.

The dispersion of values of the indicator around the mean value for the category is measured by the standard deviation for the distribution. This is shown on the graph by a vertical segment. A continuous line ———— is used for the distribution of points for the two schools; a broken line ------ is used for the distribution of points for [illegible] and EPFL respectively.

For each size category, a test was carried out for the distribution of the institutes. This test is designed to show whether the observed difference between the average y_m of a category and the average y_M for the whole of a graph can be explained by a random variation independent of size (assumption H_o) or whether it is rather related in some significant way to size (test of differences in mean values).

The rejection of assumption H_o was shown on the graph for three levels α of significance (risk of incorrectly rejecting H_o):

α = 0.15 ; symbol: o

α = 0.05 ; symbol: •

α = 0.005; symbol: ⊙

3.3 Histograms for institutes

The table in figure 2 gives the frequencies of numbers of institutes in relation to size categories for the six types of institute graphs (I, I_r, I_1, I_2, I_3, I_4). In each case, distributions are given for each school (Z, L), together with the aggregate (Z + L). The distributions for institutes between the two schools show considerable heterogeneity, according to the Brandt and Snedecor test.

It is seen that the discipline and the school are important variables for the size effects.

3.4 Some results

About 150 graphs were plotted. They show how one of the variables mentioned above is dependent on size for a combination of disciplines. The selection given here shows some significant effects concerning the research function; it is complemented by a discussion of other observations.

3.4.1 Expenditure per post. In relation with the number of posts (in full-time equivalents), expenditure by institutes diminishes slightly with size. This results essentially from the trend in staff expenditure (about 70 per cent of the total) and is due in particular to the variation in staff structure: the number of professors as a proportion of total staff declines rapidly with the size of the institute (figure 3), while posts for scientific, technical and administrative staff assisting lecturers increase with size. No systematic variations with size are noted in expenditure per post other than for staff. Differences in post expenditure noted between the smaller and the larger school show systematic variations, regardless of institute size, both for staff and other expenditure.

The graph in figure 4 shows the combined influence of size and discipline. The segments join points representing similar departments (or subject areas) in ETHZ and EPFL.

3.4.2 Publications. The graph in figure 5 shows that the total number of publications (monographs, specialised articles and other publications), when related to total expenditure, does not appear to depend in any systematic way on institute size if all institutes are considered as a whole. This is still valid when publications are related to the number of posts for assistants and researchers. On the other hand, for chemistry, physics and mathematics alone, i.e. group of disciplines I_3, a significant maximum is noted for medium-sized institutes of some 9 to 22 posts (figure 6). This is true of both schools taken individually.

3.4.3 Citations per publication. The number of citations in relation to that of publications clearly increases when the size of the institute increases. This effect is especially noticeable in the basic sciences (chemistry, physics, mathematics: group I_3) (figure 7) and in the I_4 group of disciplines (including natural sciences), which are precisely the subject areas where the citations can effectively be reckoned with the assistance of the "Science Citation Index". This observation may be compared with another finding, i.e. the number of talks presented outside, per lecturer, also increases quite significantly with the size of the institute.

3.4.4 Percentage of outside funds. The proportion of resources from government-financed funds and from third parties (notably industry) in the expenditure of an institute, represents the degree to which its activities are "self-financed" and, to some extent, its capacity to compete for research subsidies or mandates. That proportion increases on the average with the size of the institutes; this effect still exists if funds from third parties (industry) are considered alone. The analysis shows furthermore the positive influence of the proportion of external funds in input on the indicator "publications by expenditure", at any rate insofar as outside funds do not exceed the budget resources of the institute.

3.4.5 Services for third parties. The quantity of services performed for third parties by institutes was evaluated by a subjective judgement in each school, based on four levels of assessment. Services for third parties are proportionally greater in medium-sized and large institutes than in small institutes.

4. GENERAL CONCLUSIONS

The findings of the study as a whole (in addition to those set out here there are others, including some confirmation obtained through the multidimensional approach described later on) make it possible to formulate some conclusions of more general application, although it must be remembered that the relationships detected are not of a causal nature:

- there is not one size effect, but several differentiated effects depending on the relationship and level considered.

- the size effect is usually combined with other factors, such as subject area or discipline, or with past circumstances.

- without pointing to the existence of a truly critical size, convergent findings indicate a positive effect of size, particularly as regards institutes, in two areas where interaction with the outside world is a decisive factor owing to quality control:

  . access to outside sources of finance, both for purposes of research and for service activities.

  . recognition by the international scientific community, as evidenced by citations from publications and talks presented outside.

- economies of scale are readily apparent, both as regards expenditure per post and various relationships between student numbers and input.

- the variety of teaching available (options) and its individualisation (laboratories, practical exercises) generally increase with the size of departments.

5. ATTEMPT AT MULTIDIMENSIONAL ANALYSIS

5.1 Calculating overall performance

5.1.1 Justification. The unidimensional analysis described above examined the dependence on size of one variable at a time. But it is difficult to obtain an overall view, which would certainly be desirable, from partial results of this type. Hence the study was so broadened as to include a multidimensional approach, i.e. by considering several variables at once. The aggregation of data which this requires leads, however, from a sectoral standpoint, to some loss of information.

5.1.2 Theoretical possibilities. The ideal answer would be to measure the overall output of a unit (institute) and relate it to total input, and thus obtaining overall performance

in terms of productivity (the black box model). Overall output can however only be measured imperfectly, since it consists of various activities in different forms (notably teaching, research and services) which are incommensurate and can only be gauged by means of more or less arbitrary indicators. Only on the basis of dubious assumptions can overall output be reduced to a single figure by combining several indicators (weighted total or otherwise).

Another possibility can be considered a priori. This would be to formulate specific performances (again in terms of productivity) by separately relating output components with the relevant input components (which would require a model more complex than the black box). But any such separation is largely unfeasible in the case of a university unit, where teaching, research and service activities are closely interconnected (linked production). Even if this could be done, the problem would still remain of combining such specific performances, which are also incommensurable.

5.2 The pragmatic approach

5.2.1 Overall and partial performance. The approach finally adopted was somewhat different. It aims at the combination of partial performances, each defined as the relationship between an output indicator and the indicator measuring total input (thus by making use of the black box model, but without measuring overall output). This is done in two ways:

- by means of a multidimensional approach, amounting to the representation of overall performance by a series of components (vector):

$$P = (P_1, P_2, \ldots, P_n)$$

- by means of a uni-dimensional reduction, the overall performance so defined resulting from a (weighted) sum of the partial performances:

$$P = a_1P_1 + a_2P_2 + \ldots$$

where a_i are the weighting factors.

The partial performances in the test set out here are basically the same as those analysed in the graphic study previously described. Each of them is defined as a relationship between indicators, for various components I_i of output, input being measured by total expenditure D; $P_i = I_i/D$. Six output indicators were considered: I_1 = hours given, I_2 = publications, I_3 = theses, I_4 = citations, I_5 = service activities, I_6 = outside resources. The analysis was carried out in the first place in three dimensions, using the three main indicators I_1, I_2 and I_5.

5.2.2 Overcoming the lack of a common measure: the rankings. The method used to overcome the difficulty connected with the lack of a common measurement for output indicators, consists in replacing the values of the partial performances I_i/D by the corresponding rankings RI_i/D in the classification of all the institutes, separately in the case of each output. Overall performance for the institute as a whole may thus be seen as a point in a new space of n dimensions, $P = (RI_i/D, \ldots, RI_r/D)$, but whose metrics are then commensurate (since we are dealing with rankings). This advance is nevertheless achieved at the price of sacrificing absolute figures, which is acceptable if the aim is to make comparisons within a system.

It must be stressed that changing any value (cardinal measure) to a ranking (ordinal measure) is accompanied by a loss of information. Two conditions must be fulfilled if such a transformation is nevertheless to yield meaningful results (in a comparative analysis): the results must not overly depend on the transformation selected (which has been checked) and the distributions of cardinal figures must be sufficiently regular (which is the case, except for theses and citations, where a relatively large number of zero figures are to be found).

5.3 Performance and size effects

5.3.1 Statistical tests. The aim is therefore to study how overall performance (as we are able to define it) varies with institute size, this being measured in terms of staff expenditure.

The zero assumption is that there is no relationship between performance and size. To test this assumption, groups of institutes with comparable overall performances were constituted (see below). An evaluation was then made of the probability that the distribution of institutes within a given group in terms of size would not in any meaningful way constitute a random sample in the distribution of the institutes as a whole, thus leading to the rejection of the zero assumption. The procedure followed in carrying out this test amounts to drawing from a hat, without any further use being made of the lots thus drawn. This corresponds to a hypergeometric distribution which is here in most cases replaced, with certain restrictions, by a binomial distribution.

5.3.2 Formation of categories. In order to dispose of sufficiently large groups of institutes for the statistical tests, the 150 institutes covered by the study were divided into ranking categories as follows, as a kind of typology:

size:	five categories (I-V) on a logarithmic scale (see also 5.2.4)
hours/ expenditure:	four categories (1-4) all containing about the same number of institutes

publications/
expenditure: as for hours

other indicators: three categories (1-3) approximately equivalent

Ranks were thus regrouped into categories for the purposes of evaluation.

5.4 Examples of three-dimensional applications

5.4.1 Overall performance as a vector (structure). In line with the typology adopted for this approach, groups of institutes with comparable overall performances were formed by the combination of ranking categories of partial performances for the three main indicators I_1, I_2, and I_5. Overall performance is then depicted in a three-dimensional space.

This type of analysis makes it possible to see whether institutes with a certain degree of specialisation (in teaching, research of services) are distributed differently in terms of size from the institutes taken as a whole. It can be applied, as it has been, to the structure of input or alternatively to combinations of input/output structures.

5.4.2. Overall performance as a figure (summation). Assuming that it is possible to calculate overall performance by the non-weighted addition of partial performances (only seemingly non-weighted, since hours and publications by expenditure, divided into four categories, count more than services, divided into three categories), groups of institutes were formed on the basis of comparable total figures for ranking categories of partial performances for output as measured by the three main indicators. Figure 8 - the reading of which is explained below - gives an illustration for the group of institutes which are characterized by the three upper levels (9-11) of the overall performance defined as the addition of the ranks for the three following partial performances: hours of teaching divided by expenditure h/D, publications per expenditure p/D and proportion taken by services activities e/D.

5.4.3. Reading figure 8, given here as an example of what can be achieved by multidimensional analysis:

On the left-hand side are set out, in symbolic notation, the institutes forming the group in question, divided into categories according to size, and with an indication of their rankings for the partial performances examined.

The first third of the right-hand side visualises the group as so defined according to the categories selected for partial performances (here through a sum).

The second and third thirds summarize numerically and graphically the results of the statistical tests relating to the effect of size. The "Soll-wert" line contains the theoretical figures for numbers of institutes by category for a distribution reproducing that for the institutes as a whole, but for a total equal to that of the sample examined (hence the fractions). The "Ist-wert" line gives numbers observed in each size category, according to the format on the left-hand side of the page. The "Ist/Soll" line indicates the value of the relationship between the observed and theoretical values (set out in graph form underneath). The "Wahrsch." line gives the probability that the observed variation (in relation to 1) is due to chance (a probability set out schematically in the bottom third of the page). The symbols have the following meaning: •• : very low probability ($\alpha \leqslant 0.05$); • : slight but not negligible probability ($0.05 < \alpha \leqslant 0.15$); o : significant probability ($\alpha > 0.35$).

There is a "size effect" when the distribution observed for the group of institutes considered (numbers of institutes by size categories) differs in a meaningful way from the relative distribution marking all the institutes; or, in other words, when the fact of selecting institutes with given partial performances (filtering) has the effect of distorting the distribution of institutes as a function of size. It will be further noted that the tests used are in fact of the "four-field table" variety.

5.5 Provisional results of the multidimensional analysis

The findings set out below are based on the multidimensional analysis carried out so far, taking account of the indicators used and the data collected:

- according to the assumptions made, there does not seem to be any clear relationship between overall performance measured by the summation of rankings and the size of institutes (whether the principal indicators alone are used, or whether secondary indicators are also included);

- consideration of partial performances reveals, in certain cases, a significant relationship between size and the degree of specialisation;

- examination of the structure of "overall performance" (vector) broadly confirms the two preceding deductions;

- the structure of inputs (e.g. the proportion of expenditure spent on staff) sometimes reveals a high degree of dependence on size;

- the largest institutes are virtually unaffected by factors which have an effect on the other institutes.

It must be emphasized here that, in addition to the methodological limitations referred to above, the results are very much influenced by the choice and quality of indicators.

Lausanne and Zurich, 10th April, 1978.

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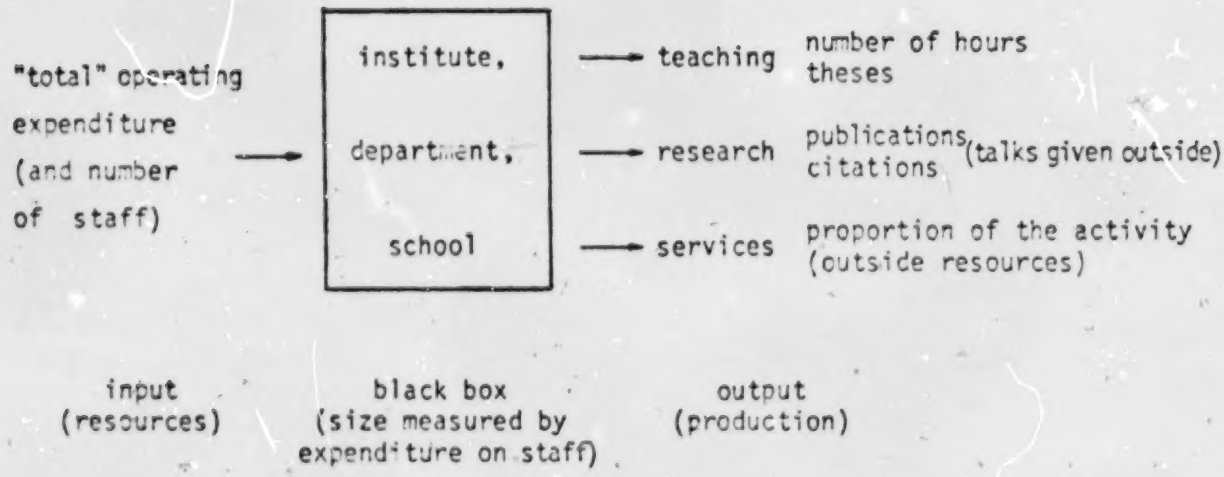
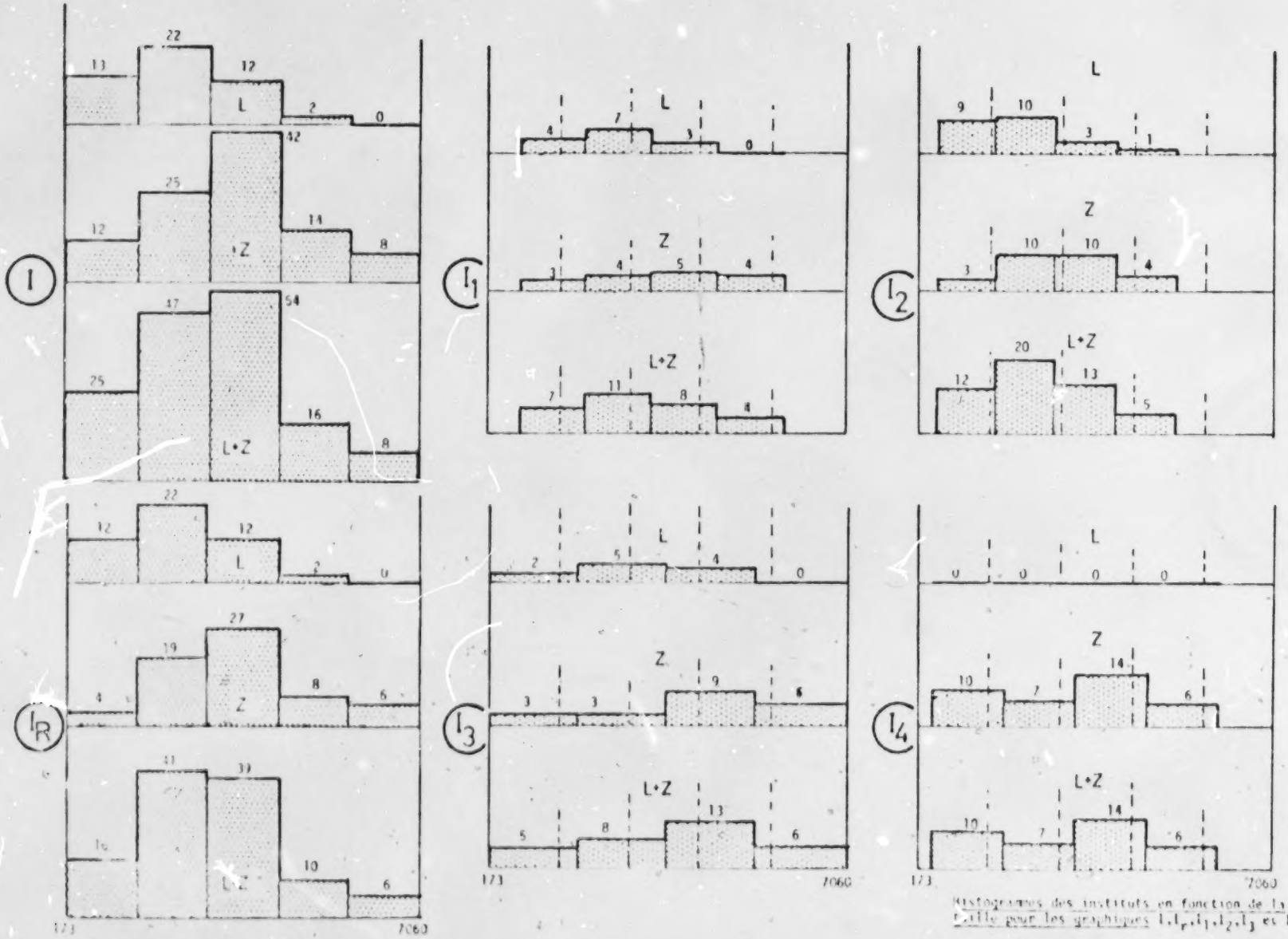
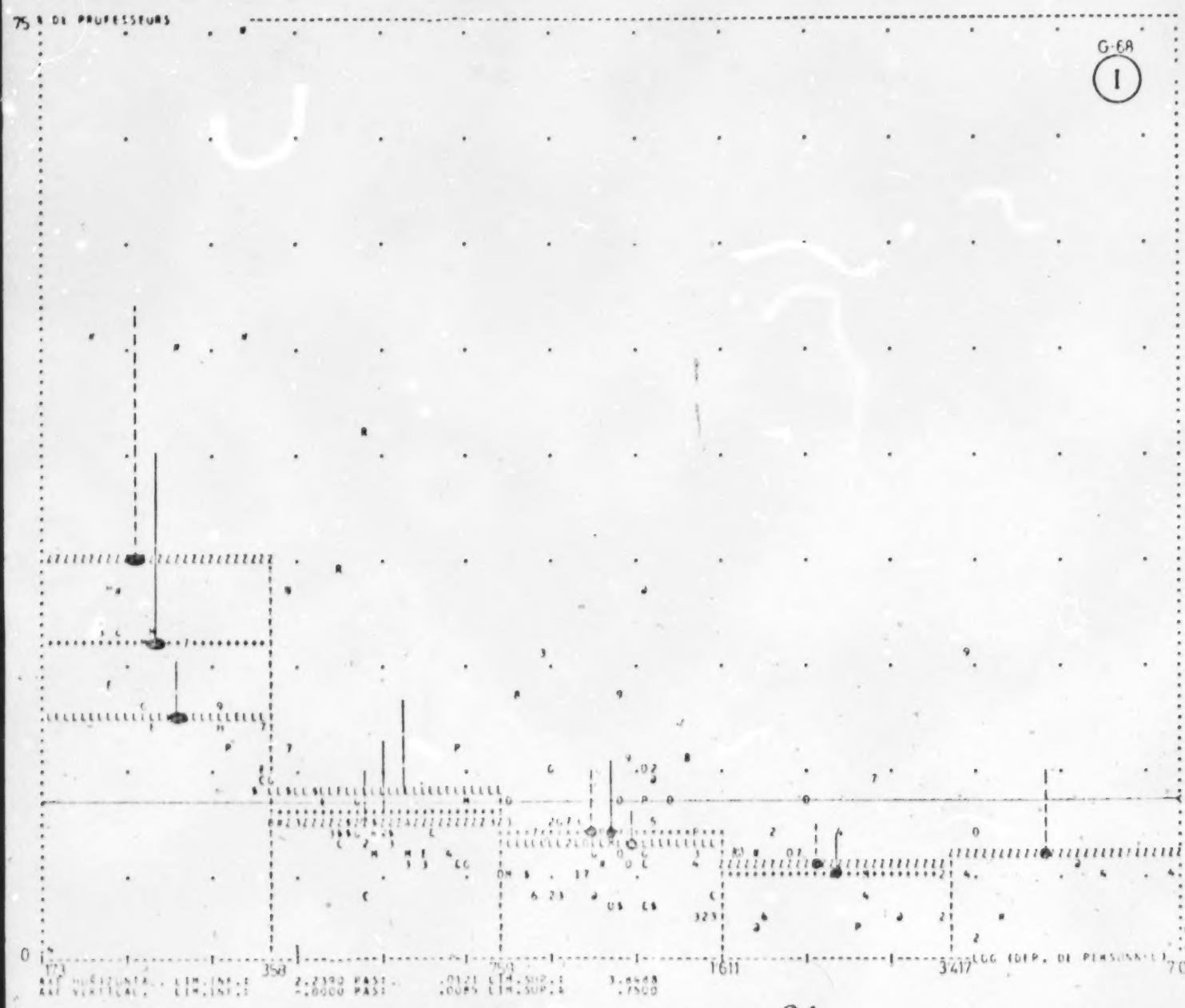
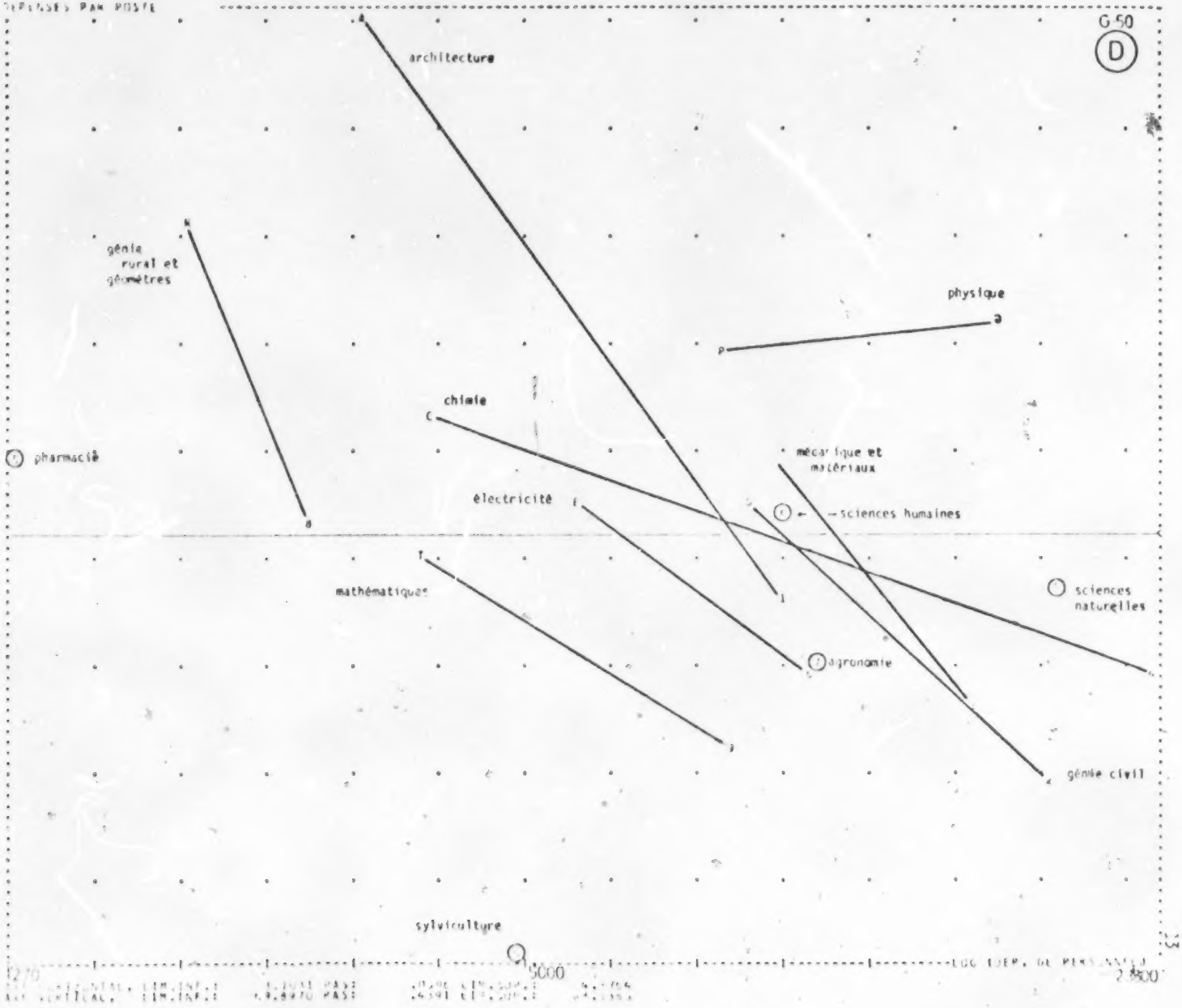
Figure 1. THE MODEL

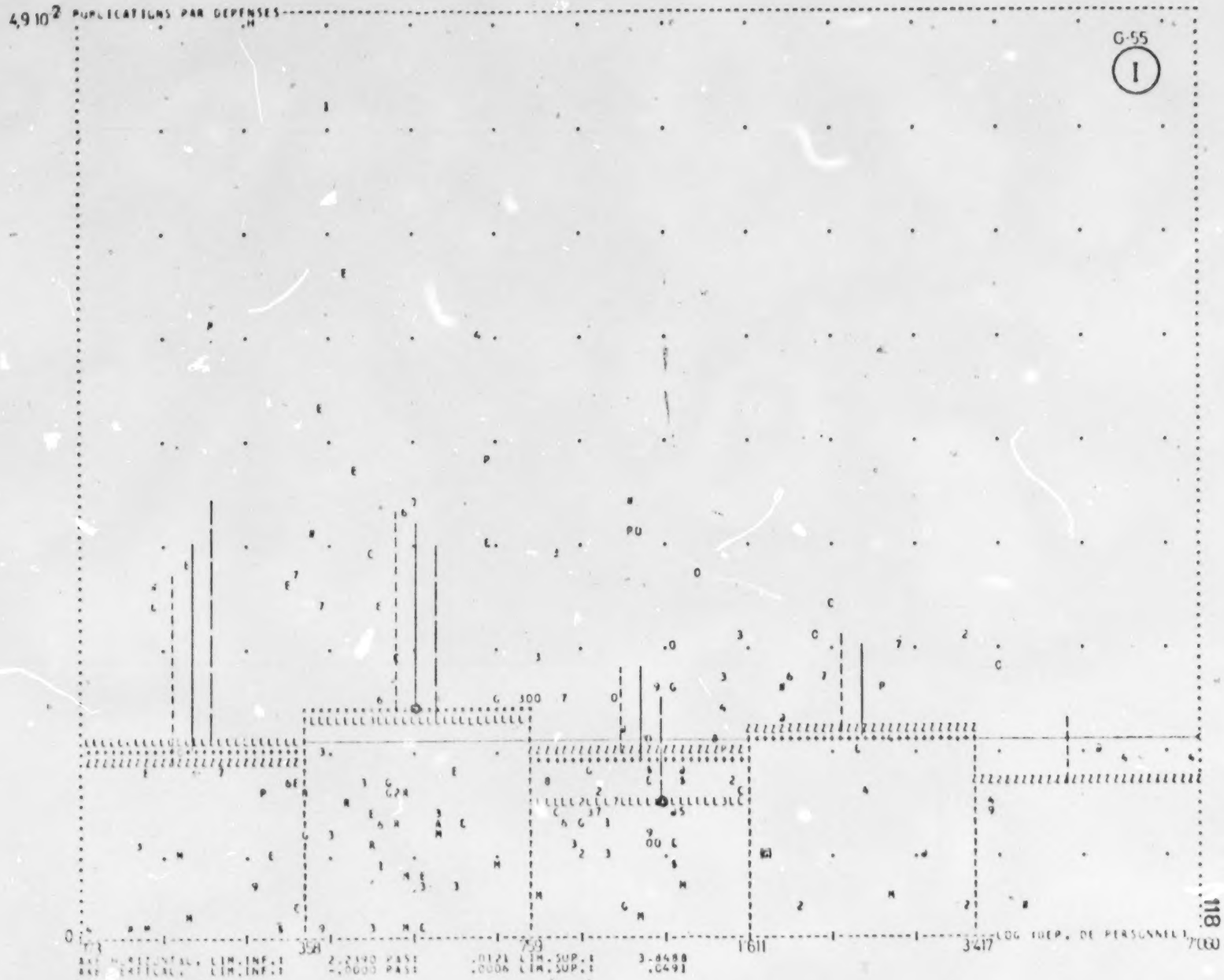


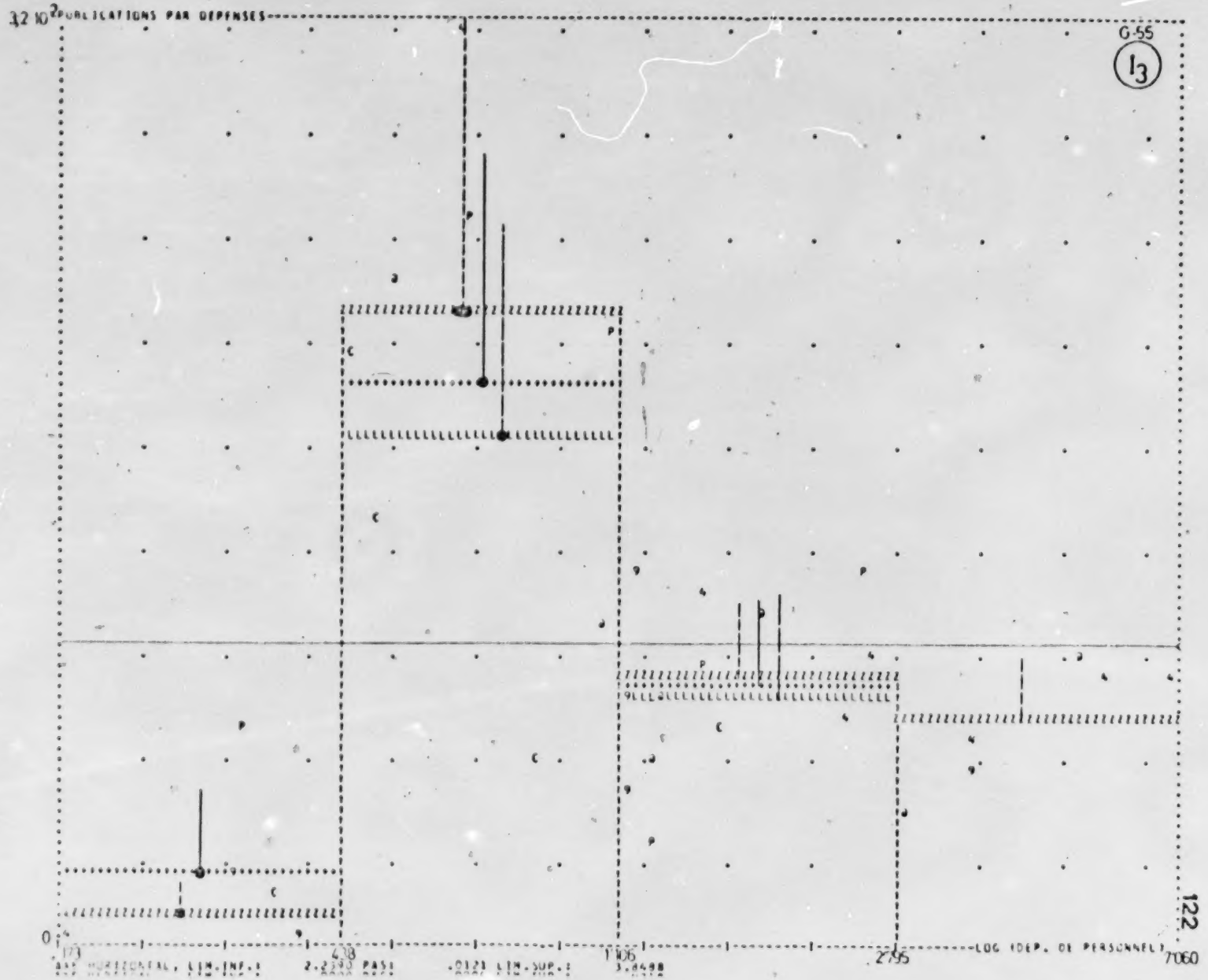


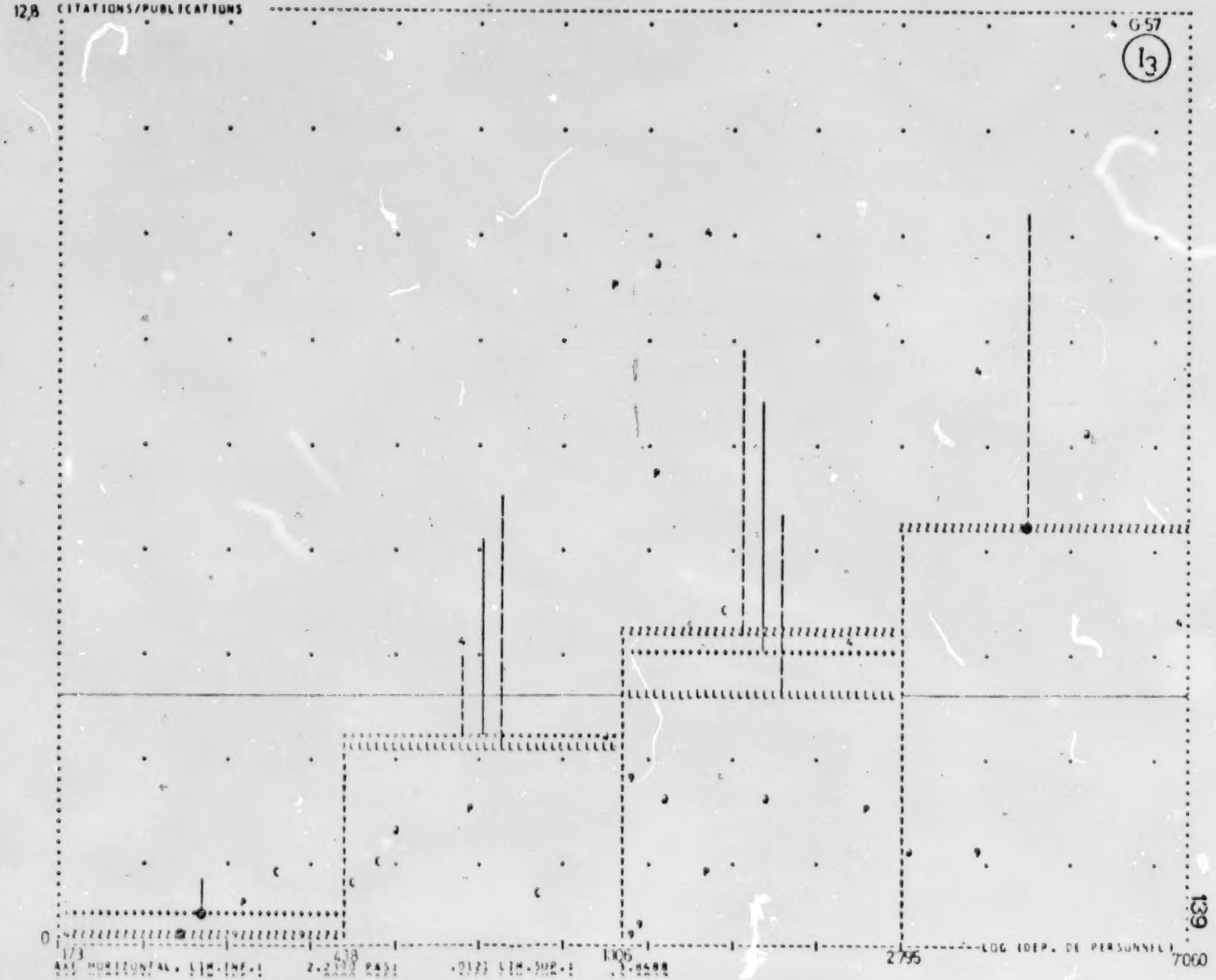
Histogrammes des instituts en fonction de la taille pour les graphiques I, I_1, I_2, I_3 et I_4.


75 % DE PROFESSEURS
G-68
1
64
0
172
358
760
1611
3417
7060
LOG (DEP. DE PERSONNES)
.02
6 23
05 65
329

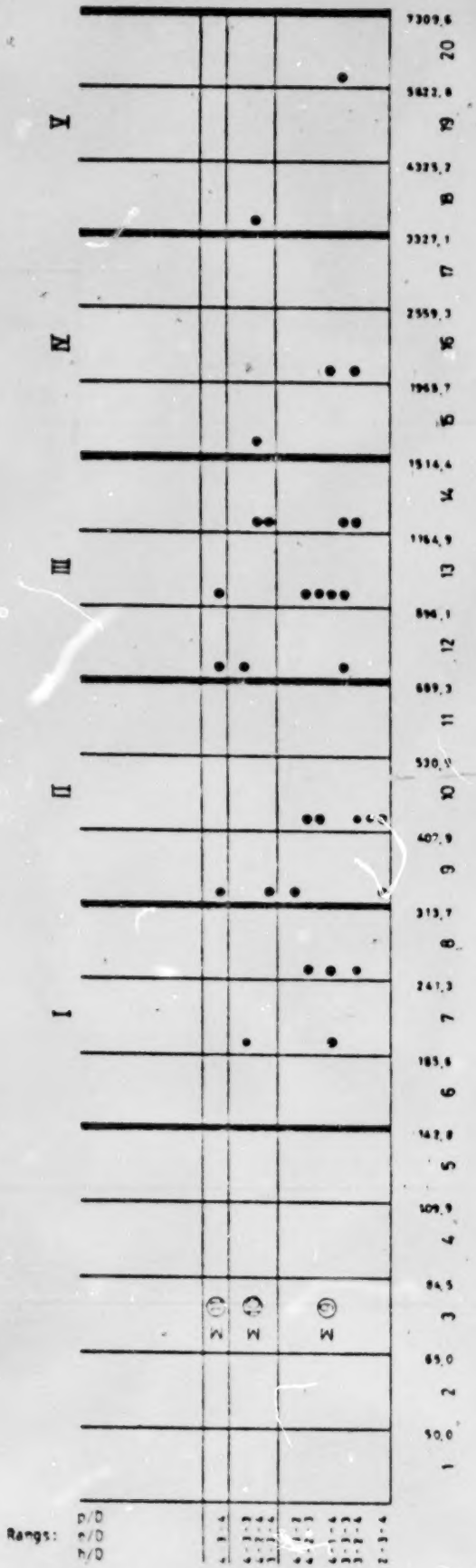

88,5
DEPASSES PAR POSTE
G 50
D
architecture
génie rural et géomètres
physique
chimie
pharmacie
mécanique et matériaux
électricité
sciences humaines
mathématiques
sciences naturelles
agronomie
génie civil
sylviculture
50
1270
5000
2 800

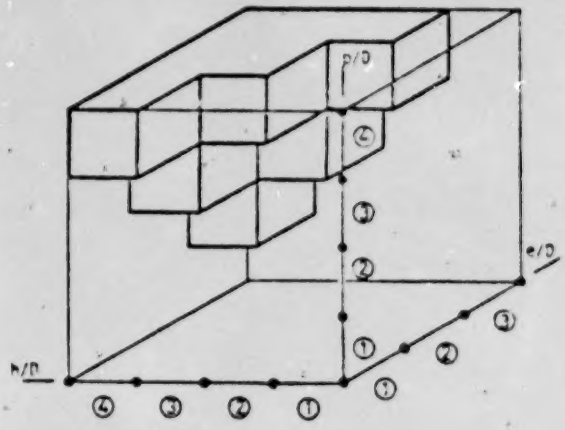

4,9 10-2 PUBLICATIONS PAR DEPENSES
G-55
1
PU
118
LOG (DEP. DE PERSONNEL)
328
1611
3417
7000
AXE HORIZONTAL LIM.INF.: 2.2190 PASS .0121 LIM.SUP.: 3.8488
AXE VERTICAL LIM.INF.: -.0000 PASS .0006 LIM.SUP.: .0491


PUBLICATIONS PAR DEPENSES
G-55
13
122
LOG (DEP. DE PERSONNEL)
7060
2705
1906
238
103
0


12,8 CITATIONS/PUBLICATIONS
G 57
13
K2
0
173
438
1106
2795
7060
LOG (DEP. DE PERSONNEL)
139

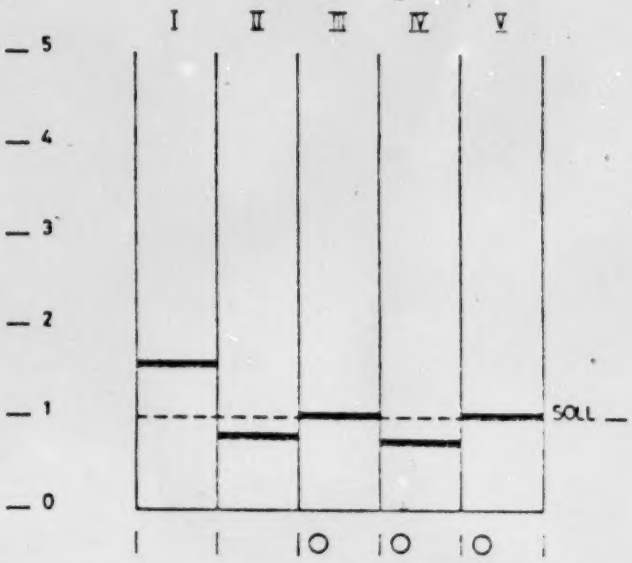
3-dim.: heures/D + publ./D + expert./D = 9 - 11





I II III IV V (Taille T)

	6-8	9-11	12-14	15-17	18-20	Σ
SOLLWERT	3,1	10,8	11,4	3,9	1,9	31
IST-WERT	5	9	12	3	2	31
IST/SOLL	1,61	0,83	1,05	0,77	1,05	
WAHRSCH	0,19	0,30	0,48	0,41	0,56	



Die Institute mit höchsten Summen der Hauptindikator-Stufen (Wochenstd./Ausg. + Publ./Ausg. + Exp./Ausg.) sind kaum abhängig von der Betriebsgrösse auf die BG I-V verteilt.

OUTPUT-HAUPTINDIKATOREN (SUMME) T 116